Jin MURATA*: Morphology and distribution of *Balanophora fungosa* J. R. et G. Forst. (Balanophoraceae)

邑田 仁*: リュウキュウツチトリモチの形態と分布

The genus *Balanophora* consists of about 20 species and is mainly distributed in temperate to tropical regions of eastern and southeastern Asia and in the western Pacific. Only one species, *B. abbreviata* Blume extends westwards to tropical Africa. *Balanophora fungosa* is another species of wide distribution geographically covering most of the range of the genus except the Chinese mainland and Africa. In his world wide monograph of *Balanophora*, Hansen (1972) recognized two subspecies of *B. fungosa*, *fungosa* and *indica*. He separated the two subspecies on sexuality of the inflorescence, subsp. *fungosa* with bisexual inflorescences and subsp. *indica* with unisexual ones, and provided a distribution map for them (Hansen 1972 fig. 9 & 1982 fig. 2).

Recently, during field observations in the Ryukyu Islands, I found a large population of *B. fungosa* subsp. *fungosa* parasitic on a tree of *Macaranga tanarius* Muell.-Arg. (Euphorbiaceae) in Arakawa, Ishigaki Is., in which most plants had bisexual inflorescences, but several with only male inflorescences (Figs. 1, 2A). This suggests that plants with male inflorescences occasionally occur in subsp. *fungosa*, and the distinction between the two subspecies by the sexuality of inflorescence alone may not be maintainable. Consequently, in this paper, the morphology and distribution of the two subspecies is reconsidered.

Hansen (1972) divided subsp. *indica* into three varieties. Variety *globosa* is apogamous and endemic to Java; only female plants are known. Variety *minor* is similar to var. *indica* but is recognized by the shape of the rhizome. This variety has been collected only three times within the range of distribution of var. *indica*. The two rare varieties, *globosa* and *minor*, are excluded from treatment here, as they are well characterized and not under consideration in this study.

Materials and methods Field observations were made in Chinen on Okinawa

---

* Botanical Gardens, Faculty of Science, University of Tokyo, Bunkyo-ku, Tokyo 112. 東京大学理学部附属植物園.

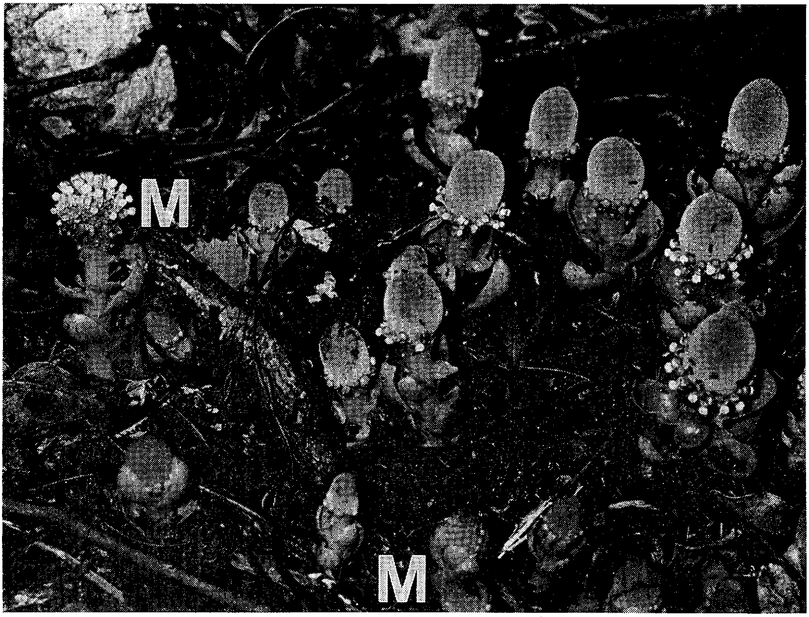


Fig. 1. *Balanophora fungosa* subsp. *fungosa* in Arakawa, Ishigaki Island, the Ryukyus (J. Murata 17053 TI). Two male inflorescences (M) are seen in the population. Many small ants are visible on and above the spadix but their effect on pollination is unknown.

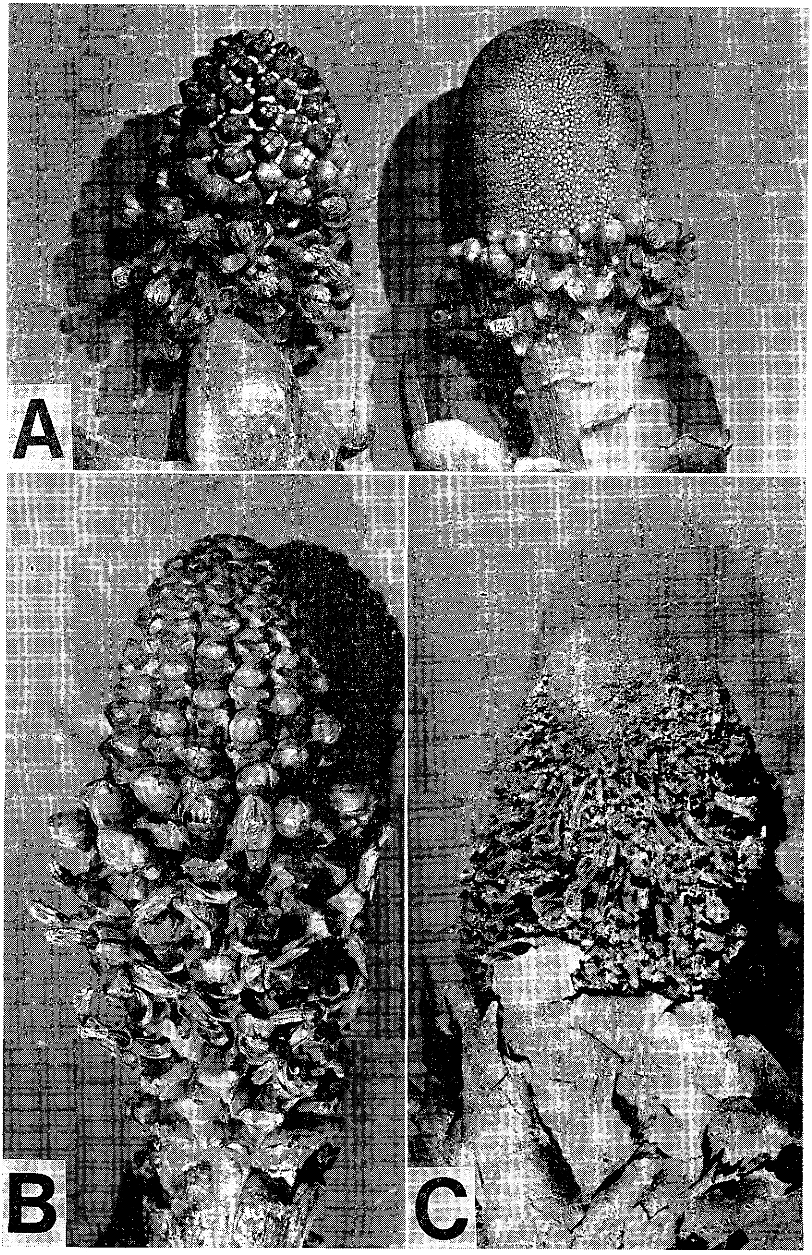
Island and Arakawa and Yonehara on Ishigaki Island in the Ryukyu Isls. Dried and liquid preserved specimens collected through field work, as well as those in BKF, KAG, KYO, TAI, TNS, TUS, TI, Herbarium of Ryukyu University, Okinawa, and authentic specimens loaned from B, BM, K, L, UC, US, WRSL, were examined.

Results and discussion

1. Observation on morphology. *Balanophola fungosa* subsp. *indica* is generally larger than subsp. *fungosa*, but the ranges in size between the two widely overlap. Hansen (1972) described the range of variation in length of the spadicle as discontinuous between the two subspecies (1100–1150 μm in subsp. *fungosa* and 1270–2500 μm in subsp. *indica*). In examining additional specimens, I found that the range of variation is not discontinuous between them. For example, a plant

---

Fig. 2. Spadix of *Balanophora fungosa* subsp. *fungosa* (A: J. Murata 17053, TI), subsp. ***indica*** var. ***indica*** (B: T. Yahara s.n., TI) and Meebold 6611 (C: in WRSL). A and B are from spirit-preserved material, C is from a dried herbarium specimen, all ×1.


A
B
C

of subsp. *indica* var. *indica* from Thailand (Yahara s.n., Fig. 2B) has short spadicles 930–1120 μm long. The shape of the spadicle also varies from clavate to narrowly clavate in both subspecies and it is therefore difficult to distinguish the two subspecies by size or shape of spadicles.

Hansen (1972) did not mention the nature of the bracts subtending the male flowers as taxonomic characters, but he described their size and shape as "short (1–2 mm), truncate, rudimentary bracts" in subsp. *fungosa* and "truncate bracts 5 mm long and 4 mm wide" in subsp. *indica*. In both the bisexual plants and male plants in the Arakawa population, and in the bisexual plants from other places, one male flower is subtended by a few, rudimentary bracts (Fig. 2A). In plants of subsp. *indica* from continental Southeast Asia male flowers are subtended by one large, truncate bract (Fig. 2B). The shape of the tepals and synandrium also differs between the two subspecies. In subsp. *fungosa*, the tepals are ovate-elliptic and the synandrium is usually subglobose and borne on a short torus less than 1 mm long. In subsp. *indica*, the tepals are elliptic-lanceolate and the synandrium is usually ellipsoid on a longer torus usually more than (1–) 1.5 mm long. Accordingly, the two subspecies are distinguishable by the shape of the bract, the tepals and the synandrium.

2. Re-determination of questionable specimens. The map given by Hansen (1972 fig. 9 & 1982 fig. 2) shows general patterns of distribution of the two subspecies. Subspecies *fungosa* is widely distributed in the western Pacific region and subsp. *indica* is distributed on the Asian continent and Sumatra (and Java for var. *globosa*). But there are some exceptions. Of the specimens examined by Hansen (1972), Meebold 6611 (WRSL) from Manipur, Kpur, India (Fig. 2C) was the only specimen of subsp. *fungosa* from the Asian continent. On the other hand, specimens from the southwestern Pacific region, such as Azaola 1846 (BM) from Luzon, Philippines (Fig. 3), Brass 19286 (L) from Cape York peninsula, Australia, and some from the Caroline and Mariana islands were reffered to subsp. *indica*. Specimens from those places were reexamined using the new morphological information discussed above.

Brass 19286 is a male specimen very similar to the male plants found in the Arakawa population. The bracts subtending the male flowers are rudimentary and the synandrium is subglobose on a short torus. I recognize this specimen as subsp. *fungosa*.

Meebold 6611 (fig. 2C) is a peculiar specimen containing two monoecious

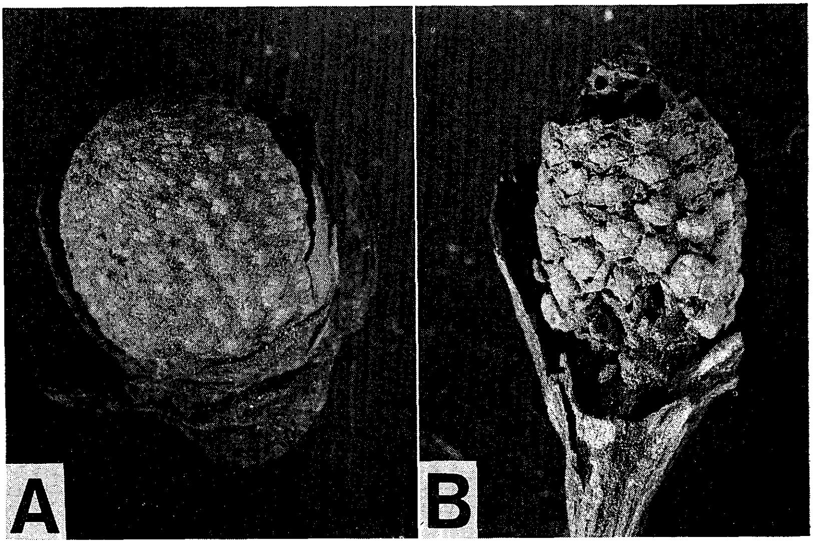


Fig. 3. Male spadices of *Balanophora fungosa* subsp. *indica* (Azaola 1846, holotype of *B. decurrens* Fawc., BM), ×3.

inflorescences. In both inflorescences, male flowers are situated in the lower part of the spadix, covering more than half of it. As the morphology and arrangement of the male flowers are irregular, especially in the upper part, it must be an abnormal form of the plant. Notwithstanding the monoecious nature of the plant, the densely arranged small male flowers, which are placed on a downwardly recurved pedicel and subtended by a slender but not rudimentary bract, do not support the placement of this specimen in *B. fungosa*. It may be refferable to *B. dioica* R. Br. ex Royle known from Nepal and Khasia previously. *B. dioica* is normally dioecious (Hansen 1982) but Hooker (1886) reported monoecious plants which were "females with sometimes a few male flowers at the base".

Balanophola pentamera Tiegh. from Guam had been considered to be endemic (Merrill 1914, Stone 1970), until Hansen (1972) recognized it as identical to *B. fungosa* subsp. *indica*. The plants from Guam are generally smaller than those of subsp. *indica* from the Asian continent but not significantly so. The morphology of the male flower is intermediate between typical subsp. *indica* and the male plant found on Ishigaki Island, but is closer to the former, especially in the morphology of the bract which is not very thick but clearly V-shaped and truncate and only one subtends each flower. Specimens with bisexual inflorescence have never been collected on Guam and the dioecious state is considered to be fixed in plants from this island. The colour of the inflorescence (spadix) of the plants from Guam is described as white (Stone 1970), which is unusual in *B. fungosa* from other localities. Although information about the plant from Guam is insufficient, I tentatively considered it to be *B. fungosa* subsp. *indica*. Specimens from the Pacific Islands other than Guam, some of which Hansen cited under subsp. *indica*, are all found to be subsp. *fungosa* with bisexual inflorescences1).

Azaola 1846 (BM), holotype of *B. decurrens* Fawc., consists of fragments of some young male inflorescences in which each male flower bud is subtended by a V-shaped bract (Fig. 3). The shape of the bracts and the actinomorphic arrangement of the tepals, as well as the pollen morphology (Hansen 1972), suggest that this specimen is very close to *B. fungosa* subsp. *indica*. I have seen no other plant similar to this specimen from the Philippines. Actually it is most similar to the plants of Guam and I included it in *B. fungosa* subsp. *indica*. Further collections are necessary to resolve the nature of these dioecious plants of the Pacific region.

The occurrence of *B. fungosa* had not been reported from Taiwan until *B. fungosa* subsp. *fungosa* was found in Henchung district in the southernmost part of Taiwan (Hsu 1983). Since Matsumura & Hayata (1906), the plants of Lanyu Is. (Botel Tobago), about 80 km east of Henchung, had been described as dioecious and referred to *B. dioica*. The only specimen that was cited in Matsumura & Hayata (1906), Miyake s. n. (TI), however, is *B. fungosa* subsp. *fungosa* with some male flowers below the female part of the spadix. Recently, a good specimen of *B. fungosa* subsp. *fungosa* was collected again from this island (Chang 11640 TI). A photograph in Hsu (1982) also suggests that *B. fungosa* subsp. *fungosa* occurs in this island. It is notable that not only a monoecious inflorescence with a few male flowers below the female flowers, but also a female (unisexual) inflorescence are seen in the photograph. The reports of *B. dioica* from Lanyu Is. may be based on such female individuals of *B.*

---

1) These specimens are correctly annotated as *B. fungosa* subsp. *fungosa* by Dr. Hansen himself.

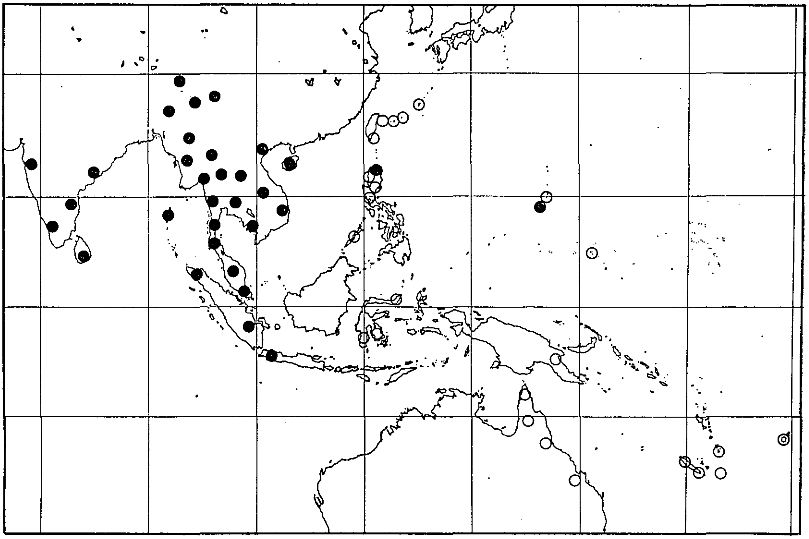


Fig. 4. Distribution map of *Balanophora fungosa* subsp. *fungosa* (open circles) and subsp. *indica* (solid circles), revised from Hansen (1972).

fungosa subsp. *fungosa*.

3. Distribution. A revised distribution map of *B. fungosa* is given in Fig. 4. The general pattern of distribution of this species is similar to that of the tropical rain forests in Asia and in the Pacific region. Although it is widely distributed, it has never been collected in Borneo. The western part of the distribution range (west of Borneo) is exclusively occupied by subsp. *indica* and the occurrence of subsp. *fungosa* is east of Borneo. The occurrence of subsp. *indica* on Luzon and Guam is the only exception of this vicarious pattern.

Taxonomic conclusion

Balanophora fungosa J.R. et G. Forst., Char. Gen. Pl. 99, t. 50 (1776) ; Fl. Ins. Austr. Prod. 64, no. 333 (1786)—B. Hansen, Dansk Bot. Arkiv **28** : 93 (1972) ; Acta Phytotax. Geobot. **33** : 101 (1982). (For synonyms and literature see Hansen 1972).

subsp. **fungosa**

B. dioica auct. non R. Br. ex Royle : Matsumura & Hayata, Journ. Coll. Sci. Univ. Tokyo **22** : 358 (1906)—Yamamoto, Ann. Rep. Taihoku Bot. Gard. **1** : 94 (1931)—T.S. Liu, Sasaki & Keng, Quart. Journ. Taiwan Mus. **8** : 290 (1955)—

T.S. Liu & M.J. Lai, Fl. Taiwan **2**: 225 (1976)—G.S. Hsu, Pl. Lanyu 54 (1982).

B. fungosa: G.S. Hsu et al., Pl. Hengchun Penins. 29 (1983).

Specimens examined. Japan, Ryukyu Isls.: J. Murata 17053, 17054, Ishigaki Is., Yonehara, Dec. 27, 1983 (TI); J. Murata 17051, 17056, ibid., parasitic to *Diospylos ferrea* (TI); J. Murata 17055, ibid., parasitic to *Pongamia pinnata* (TI); J. Murata 17052, Ishigaki Is., Arakawa, about sea level, parasitic to *Macaranga tanarius*, Dec. 27, 1983 (TI); J. Murata & K. Nakajima 21468, Okinawa Is., Shimajiri-gun, Chinen, Feb. 18, 1986 (TI).

Taiwan. Lanyu Is. (Botel Tobago): K. Miyake s.n., Dec. 1899 (TI); ibid., S.Y. Chang 11640, Mt. Chingswei, Jan. 29, 1978 (TI).

Mariana Isls.: Hosokawa 7880*[2] (TAI); Stone 5255* (L); Togashi s.n., Rota Is., Mt. Sabana, 300 m, Dec. 23, 1977 (TI); Tuyama s.n., Saipan Is., Tagpochao, Feb. 6, 1941 (TI); Tuyama 424, Rota Is., Sabana, Zyodan, Hanare-koti, Feb. 17, 1941 (TI); Volkens 114* (B).

Caroline Isls.: Hosokawa 8295* (TAI), 8336* (TAI), 8431* (TAI, TNS); Kanehira 1298* (TAI); Tuyama s.n., Truk Is. Akishima, Mt. Trukchap, Feb. 1, 1941 (TI); Tuyama s.n., Truk Is. Natsujima, Feb. 1, 1941 (TI).

Australia: Brass 19285* (L), 19286* (L), 19323* (L, TNS), 20223* (L).

subsp. **indica** (Arn.) B. Hansen, l.c. 100 (1972).

var. **indica**

B. pentamera Tiegh., Ann. Sci. Nat. Bot. Ser. 9, **6**: 151 (1907)—Stone, Micronesica **6**: 261 (1970).

Specimens examined. Philippines. Luzon Is.: Azaola 1846* (BM).

Mariana Isls., Guam Is.: Mc Gregor 566* (K); GES 227* (K, US); Stone 3779* (L); Steere 25* (US); Conover & Wagner 3592* (UC).

Thailand: Charoenphol et al. 4204*, 4588* (BKF); Garrett 636* (BKF); Geesnik et al. 8168, Chiang Mai, Doi Chiang Dao, 2000–2250 m, Jan. 7, 1975 (BKF); Hansen & Smitinand 12821* (BKF), 12824* (BKF); Hennipman 3119B* (BKF), 3186* (BKF); H. Koyama et al. 30074, Nakhorn Ratchasima, Haew Suwat waterfall, Khao Yai National Park, Pakchong Distr., 700–730 m, Nov. 19, 1982 (KYO); H. Koyama et al. 30166 Nakhorn Ratchasima, near Krok Hinlap fall, Khao Yai National Park, Pakchong Distr., 370 m, Dec. 17, 1982 (KYO); H. Koyama et al. 30292, Kanchanaburi, Huay Lam Ton, Erawan National Park,

---

[2] See Hansen (1972) for data from the specimens marked with an asterisk.

Srisawat Distr., 580-600 m, Nov. 26, 1982 (KYO); H. Koyama et al. 31474, Khon Kaen, Pha Nuk Khao, Chum Phae Distr., 320-470 m, Dec. 21, 1982 (KYO); H. Koyama et al. 31871, Phetchabun, Thung Salaeng Luang National Park, Wang Thong Distr., 500-550 m, Dec. 28, 1982 (KYO); H. Koyama et al. 33404, Chiang Mai, Doi Pha Hom Pok, Fang Distr., 1600-2350 m, Feb. 12, 1983 (KYO); G. Murata et al. 15085, Chiang Mai, higher elevation of Doi Chiang Dao, 1300-1900 m, Sept. 26, 1971 (BKF, KYO); T. Shimizu et al. 19299, Chiangmai, Nang Kruan Waterfall, Bo Luang Table-land, Om Koi Distr., 950-1000 m, Oct. 18, 1979 (BKF, KYO); T. Shimizu et al. 22552, Khon Kaen, Pha Nuk Khao, Chum Pae Distr., 310 m, Nov. 17, 1979 (BKF, KYO).

Sumatra: K. Iwatsuki et al. 974, Atjeh, middle elevation of Gunong Kemiri, 1600-1800 m, Aug. 26, 1971 (KYO).

I wish to thank Prof. K. Iwatsuki, director of the Botanical Gardens, Faculty of Science, University of Tokyo, and also the staff and colleagues at the Botanical Gardens, for their valuable suggestions and assistance. Thanks are also due to the directors and curators of the cited herbaria for allowing me to study specimens in their care. I am grateful to Mr. S.Y. Chang of Pintung Institute of Agriculture, Taiwan, who provided specimens from Lanyu Island and to Dr. T. Yahara of the Botanical Gardens, Nikko, University of Tokyo, and Mr. T. Nagamasu of Kyoto University who brought the spirit material and photograph of the natural habitat of *Balanophora* from Thailand. Mr. K. Nackejima of Okinawa Prefecture, Japan, kindly helped me in the field. I express my gratitude to Dr. H. Ohashi, Prof. of Tohoku University, Sendai, and Dr. D.E. Boufford of the Harvard University Herbaria, for critically reading this paper.

Literature cited

Hansen, B. 1972. The genus *Balanophora*, a taxonomic monograph. Dansk Bot. Arkiv **28**: 1-188. —— 1982. The Balanophoraceae of the Pacific. Acta Phytotax. Geobot. **33**: 92-102. Hooker, J.D. 1886. *Balanophora, in* Fl. Brit. Ind. **5**: 237-238. Hsu, G.S. (ed.) 1982. *Balanophora dioica, in* Plants of Lanyu 54. Taiwan Provincal Department of Education, Taiwan. —— et. al. 1983. *Balanophora fungosa, in* Plants of the Hengchun Peninsula 29. Taiwan Provincal Department of Education, Taiwan. Matsumura, J. & B. Hayata 1906. Balanophoraceae, *in* Enumeratio Plantarum. Journ. Coll. Sci. Imp. Univ.

Tokyo. **22**: 358–359. Stone, B. C. 1970. Balanophoraceae, *in* The flora of Guam. Micronesica **6**: 261–262.

*　*　*　*

Hansen (1972, 1982) は性表現の違いを識別点として *Balanophora fungosa* に2つの亜種を認め，それらの分布図を示した。Hansen によれば，狭義のリュウキュウツチトリモチ subsp. *fungosa* は雌雄同株で雌花群の下に雄花群がつく両性花序を持ち，subsp. *indica* は雌雄異株であることにより区別される。ところが，石垣島において，1本のオオバギに寄生する subsp. *fungosa* の集団の中に，通常の型と混じって数個の雄株が発見され (Fig. 1)，性表現だけでは2亜種が識別できないことが明らかとなった。そこで本論文では，両亜種の形態上の差異について再検討し，その結果に基づいて分布図を改訂した。これら2亜種は花序の大きさや雌花部の特徴では識別が困難であるが，雄花に付随する苞および雄花の花被片と雄ずい群の形状が次のように異なる。Subsp. *fungosa* の雄花には通常数個の，繊細な苞があり，花被片は楕円形で雄ずい群がほぼ球状であるのに対し，subsp. *indica* では，1個の雄花に対応して1個の大型の苞があり，花被片は長楕円形で雄ずい群は楕円形である (図 2A, B)。分布域はボルネオを境としておおよそ東西に分かれているが，ルソン島およびグァム島に subsp. *indica* とみなされるものが分布しているのが注目される。これらについては今後さらに検討することが必要と思われる。なお，台湾には最近まで本種の分布が知られていなかったが，恒春半島と蘭嶼に subsp. *fungosa* が生育していることが確認された。

□堀田　満(編)：**京都・植物たちの物語**（古都の花と緑と作物）272 pp. 1987. かもがわ出版，京都. ¥2,000. 京都に見られる植物を紹介して解説したものである。平安時代の昔から日本の中心として文化のはぐくまれた所だから，そこで育成された蔬菜，果樹類が多く，それらが内容の大部分を占めている。聖護院カブ，壬生菜，スグキ，九条ネギ，丹波栗，北山スギなどよく知られたものや，聞いたことのない珍しいものもでてくる。菜の花漬に利用するため，現在他所では無くなってしまった在来のアブラナが残っている等面白い記事もある。週刊誌「京都民報」に連載したものをまとめたものなので，一般向の内容になっていて，折角の伝統のある植物が軽く解説されているのは物足りない。椿の園芸化は京都で始まったもので，大徳寺の胡蝶侘助，地蔵院の五色の散椿など多くの由緒ある古木があるし，石川丈山が愛したと言われる詩仙堂のサザンカなど，京都の歴史を物語るいろいろな植物がでてこないのは残念である。蔬菜，果樹類と花卉園芸品とは別の本にして書いたら，もっと内容の豊かなものになったろうと，折角の好企画が惜しまれる。B 6判。　(山崎　敬)